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Notes.

Powers used, 240 and 282.

1895 Oct. 29, planet low; bad definition. Nov. 30, windy; planet low; much motion. Dec. 1, clouds; violent motion. Dec. 9, stormy; no definition. 1896 Jan. 24, windy and wet. Feb. 6, bad definition. Feb. 9, planet low; much boiling. Feb. 13, overcast sky. Feb. 23, much motion. Feb. 24, good definition. Mar. 1, stormy. Mar. 2, very stormy. Mar. 8, stormy. Mar. 9, good definition. Mar. 12, misty. Mar. 16, stormy. Mar. 17, windy; clouds. Mar. 18, good definition. Mar. 19, good. Mar. 23, much cloud. Mar. 30, much cloud. Apr. 2, clouds. Apr. 3, good. Apr. 8, good. Apr. 9, windy; cloud. Apr. 10, windy; cloud; much motion. Apr. 11, windy. Apr. 13, good. Apr. 17, fair; cloud. Apr. 18, fair. Apr. 20, good; mist. Apr. 21, good. Apr. 24, fair; in twilight. Apr. 25, bad. Apr. 26, bad. May 3, good. May 10, fair; first obs. made 1^h before sunset. May 11, fair.

The powers used were 150 when definition was bad, 240 on most occasions, and 330 and 470 when the image was very steady and the sky clear.

On certain Phenomena presented by Jupiter's Satellites and their Shadows during Transit, with a Note on the Red Spot; and on some Methods of observing the Transits of Bright and Dark Spots across the Central Meridian. By J. Gledhill.

Careful observations of the changes which the satellites and their shadows undergo while in transit across the disc of Jupiter are slowly accumulating. Among recent contributors the names of Pritchett, Trouvelot, Tebbutt, Barnard, Denning, Spitta, and Williams may be mentioned. The elaborate researches of Spitta, together with the suggestions and theories of Burton, Proctor, Schaeberle, Holden, Hough, Williams, and others, constitute a real advance in the direction of a scientific explanation of these interesting phenomena. It was with the view of widening the basis for such investigations that the following observations were made. The instrument used was the 9⅓-in. Cooke equatorial refractor, powers 240 and 270, Huyghenian, and 282 on the Simms' micrometer. The observations were begun in the early morning hours of 1895 October, and concluded in the early evenings of May of the present year.

Satellite I.

Satellite I. in transit 1896 March 2: ingress at $8^h\ 48\frac{1}{2}^m$; invisible about $9^h\ 10^m$. It passed along the bright central zone of *Jupiter*.

Satellite I. in transit, 1896 March 9: ingress at $10^h\ 36^m\ 20^s$. It traversed the bright central zone just below (to north of) the ruddy double belt, and was a bright and conspicuous object when just within the disc. At $10^h\ 42^m$ it was less bright, and gradually grew fainter till $10^h\ 55^m$, when it was just visible; it was invisible at 11^h. At $11^h\ 10^m$ it reappeared as a very faint

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dusky round spot, was darker at 11^{h} 15^{m}, and easily seen as a dusky spot at 11^{h} 30^{m} ; central about 11^{h} 38^{m}, faint at 11^{h} 50^{m}, and seen with difficulty at 12^{h}.

Satellite I. in transit 1896 March 18 : ingress at 6^{h} 52^{m} 25^{s}, just visible as a bright disc at 7^{h} 10^{m}, invisible at 7^{h} 15^{m}, and till 7^{h} 30^{m} ; at 7^{h} 33^{m} it was seen as a dusky spot ; it grew darker, and so continued till 8^{h} 30^{m} ; at 8^{h} 40^{m} it was less dark ; very faint at 8^{h} 50^{m}, and invisible at 9^{h}. It was not so bright when just about to leave the disc as it was at ingress when just within the eastern limb.

Satellite I. in transit, 1896 March 25 : ingress about 8^{h} 40^{m} ; brighter than the limb of *Jupiter* when just within the disc at 8^{h} 50^{m} ; very faint at 9^{h} ; invisible at 9^{h} 10^{m} ; a dusky spot at 9^{h} 30^{m} and 10^{h} ; darker at 10^{h} 15^{m} and onwards ; clouds prevented further observation. The satellite traversed the bright central zone about $1\frac{1}{2}''$ to the north of the ruddy double band which lies just to the south of *Jupiter's* equator.

Satellite I. in transit 1896 April 10 : ingress at 6^{h} 57^{m} ; it moved along the bright central zone and near the ruddy belt ; was much brighter than the adjacent surface of *Jupiter* at ingress ; growing faint at 7^{h} 10^{m} ; very faint at 7^{h} 15^{m} ; invisible at 7^{h} 30^{m} ; reappeared as a grey spot at about 7^{h} 40^{m}, and so continued till 8^{h} 50^{m} ; invisible at 9^{h} ; brightening at 9^{h} 5^{m}.

Satellite I. in transit 1896 April 17 : ingress about 8^{h} 46^{m} ; brighter than the limb of *Jupiter* ; grew gradually fainter, and was invisible at 9^{h} 10^{m} ; reappeared at 9^{h} 30^{m} as a grey spot.

The Shadow of Satellite I.

On 1896 March 18 the shadow was slightly elongated in a direction parallel to the belts, and seemed smaller at ingress than just before it left the disc.

In transit 1896 April 3 : ingress at 8^{h} 30^{m} 20^{s} ; clouds prevented observation until the shadow had passed the central meridian of *Jupiter's* disc. Between the c. meridian and the western limb the shadow for some time appeared perfectly circular ; it then became elongated in a north and south direction, then showed a penumbral fringe on its east and west sides, and then became elongated in a direction not quite parallel to the belts of *Jupiter.*

Satellite II.

In transit April 8 : ingress about 6^{h} 48^{m} ; not seen from 7^{h} to 9^{h} ; still invisible at 9^{h} 20^{m} ; quite bright and near the western limb of *Jupiter* at 9^{h} 30^{m}.

Satellite III.

In transit 1896 March 1 : ingress at 6^{h} 51^{m} ; at 7^{h} invisible ; seen as a dusky spot at 7^{h} 20^{m} ; it so remained till 9^{h} 40^{m} ; at

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$9^h\ 55^m$ it was not so dark; at $10^h\ 5^m$ not easily seen; at $10^h\ 10^m$ invisible.

In transit 1896 March 8: brighter than the limb of *Jupiter* at ingress; soon became a dark spot. It was on the ruddy belt just south of the equator. The weather was bad, and further observations impossible.

In transit 1896 April 13: the satellite became quite dark, nearly as black as a shadow, soon after ingress, and continued so all the way across the disc of *Jupiter* till $8^h\ 18^m$, when it became less dark; grew gradually fainter till $8^h\ 25^m$; was invisible at $8^h\ 30^m$ and $8^h\ 34^m$, and quite bright at $8^h\ 35^m$, when near egress.

In transit 1896 April 20: it moved along the ruddy belt just south of *Jupiter's* equator; was brighter than the adjacent surface of the planet at $9^h\ 6^m$; growing fainter at $9^h\ 10^m$; still easily seen at $9^h\ 15^m$; just visible at $9^h\ 23^m$; appeared as a grey spot at $9^h\ 25^m$; darker at $9^h\ 30^m$; at 10^h nearly as dark as a shadow, and so continued till after 12^h.

The Shadow of Satellite III.

In transit 1896 February 23: ingress at $6^h\ 13^m$; very large, black, distinctly elongated in a direction not quite parallel to the belts of *Jupiter*, and so remained for half an hour, then became circular. It was a most striking object for some time, indeed, until it had passed the central meridian. As it passed away from the meridian westward it became altogether a less conspicuous object, and so remained quite up to egress. The definition was so good that all the stages of the egress were easily observed—round when in contact, then imperfect, then half had disappeared, then a black crescent-like form, finally, a thick black curved line, and then total disappearance at $9^h\ 45^m\ 30^s$.

In transit 1896 March 1: ingress at $10^h\ 12^m\ 30^s$, and was black and circular in shape, and of its usual appearance throughout the transit.

An exceptionally fine view of the disappearance of Satellite III. in *Jupiter's* shadow was obtained on 1896 March 19. From 8^h to 9^h the definition was very fine indeed, and the various stages of disappearance were so beautifully seen as to call to mind Professor Pickering's account of these phenomena as seen at Arequipa—"*Phase.* We now come to an observation of which only the most favourably located telescopes are capable, that of watching the change of shape as the satellite enters the shadow of its primary." "The phases of *Jupiter's* satellites are readily observed as they enter into the shadow of the planet, a phenomenon which it is thought but few astronomers have ever seen even with much larger telescopes than the 13-inch" (*Astronomy and Astrophysics*, vol. xi. p. 355). On the present occasion every phase was distinctly and easily seen—full orb just before the satellite touched the shadow, slight deformation, bisection, a delicate crescent-like form, a fine curved line of light, then a minute speck of light just before complete extinction. It is perhaps needless to add that no trace of the penumbra of *Jupiter's* shadow was seen on the satellite, a very high power and a still finer sky being necessary for such an observation.

Satellite IV.

In transit 1896 April 21 : ingress about $3^{h}\ 56^{m}$; when first seen, before sunset, it was a fine object well advanced on the disc of *Jupiter* ; it was circular and as black as a shadow, and so remained till it approached the western limb, when it became smaller but not less dark. When one half of the satellite still remained on the disc, the other half could not be seen against the dark sky ; and even when the whole disc of the satellite was off the planet it was probably no brighter than one of the grey belts. At about 9^{h} it became brighter. During transit it moved along the south edge of the ruddy belt.

The Shadow of Satellite IV.

In transit 1896 March 19 : watched it from 6^{h} till egress ; circular till $7^{h}\ 15^{m}$; then distinctly elongated in a direction perpendicular to the belts of *Jupiter*, and thus remained till $7^{h}\ 45^{m}$. It moved along the ruddy band.

NOTE ON THE RED SPOT, &c.

Throughout the whole of the present apparition of *Jupiter* the Red Spot was carefully looked for when in transit, but was never, even on nights of good definition, distinctly and steadily seen. Its outline was occasionally seen for a moment. No colour was ever seen within the outline. Some adjacent features, however, could not be overlooked, viz. the *Preceding Shoulder*, the *Following Shoulder*, and the great trough between them under the Red Spot. A few measures were made of the distance from shoulder to shoulder, but owing to the faintness of the preceding shoulder they were but rough : 1896 February 26, $11''\cdot8$; $11''\cdot1$ on March 12 ; and $11''\cdot9$ on April 29, all reduced to $\Delta = 5\cdot20$. The depth of the trough, from the south edge of the south equatorial belt (here quite narrow) to the north edge of the south temperate band, and through the Red Spot, was $4\frac{1}{2}''$ on 1896 March 12.

Although the preceding and following shoulders and the trough between them do not offer any very definite points for the eye to rest on, attempts were made to obtain the times of their transits across the central meridian with the following results :—

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The Preceding Shoulder.

1896.	h m	°		h m	°
Mar. 2	8 44	λ=354·8	Apr. 2	9 16	λ=351·0
9	9 30	354·4	9	9 59	349
12	7 0	353·5	24	7 33	351·6
16	10 10½	350	May 6	7 35	353·8
19	7 45	353·3			

The Middle of the Hollow or Trough.

Feb. 26	9 55	λ=6·2	Apr. 9	10 30	λ=7·0
Mar. 9	9 53	8·4	12	8 0	6·5
12	7 23	7·4	May 6	7 55	5·9
16	10 37½	6·6	9	5 30	8·7
Apr. 2	9 42	6·7			

The Following Shoulder.

Mar. 2	9 32½	λ=24·1	Apr. 29	7 38	λ=25·3
9	10 23	26·4	May 6	8 27	25·3
12	7 52	24·9	9	5 58	25·6
16	11 0	26·6	11	7 38	26·2
Apr. 2	10 12	24·8	13	9 17	26·2
9	11 0	25·0			

Note on some Methods of Observing the Transits of Bright and Dark Spots across the Central Meridian.

It has occurred to me that the following notes might be of some use to Fellows of the Society who live at a distance from London, and to whom many of the Continental and American astronomical publications are not readily accessible.

1. *Simple eye-estimations.*—This is no doubt the method in most general use by amateur astronomers, and it may be encouraging to many to know that it was the method exclusively practised by Mr. Barnard for many years. When skilfully used the results obtained are comparable with ordinary micrometrical measures. "Careful eye-estimates," writes Mr. Barnard, "I think, should have the same value as micrometrical measures for determining the times of transit of the spots on *Jupiter*" (*Monthly Notices*, vol lii., p. 11). And again: "Among the observations of the Red Spot I have forty-four complete and carefully estimated transits—that is, observations of the preceding end, middle, and following end of the spot. Twenty-one of these are from a single but careful estimate of each phase. These give a probable error of a transit of the centre from the mean of the three observations $= \pm 1^{\mathrm{m}}{\cdot}0$. In twenty-three of these transits three estimations were made of each phase; from these I get for the transit of the middle from the mean of the time observations the error

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of the transit $= \pm 0^{\mathrm{m}}\cdot 7$" (*Publications of the Astronomical Society of the Pacific*, vol. i., p. 91). He further found that his observations of the Red Spot "indicate a probable error of $\pm 0^{\circ}\cdot 44$ or $\pm 0^{\mathrm{m}}\cdot 73$ in the determination of the time of transit by a single estimate."

On the other hand, it is well to remember Mr. Marth's warning after he had reduced a large number of estimated times of transit of the Red Spot by various observers. He writes: "The discrepancies between the observations of different observers and on different days point to the existence of some grave sources of error, and show the necessity for greater care and caution" (*Monthly Notices*, vol. xl., pp. 420–428).

Again: Dr. Schmidt paid considerable attention to this subject, and in his papers in the *Astronomische Nachrichten*, Nos. 2,342 and 2,410, discusses 180 observations of transits of the Red Spot. He finds a mean error of $2^{\mathrm{m}}\cdot 57$ for the time of transit; that personal equation affected the results of different observers to an extent varying between $+3^{\mathrm{m}}\cdot 6$ and $-5^{\mathrm{m}}\cdot 8$; and, lastly, he detected a systematic error in the observations depending on the hour angle, its maximum value being 7^{m}. (See also *Astronomy and Astro Physics*, vol. xi., 1892.) On the whole, it may be said that there is a probable error of $\pm 2\frac{1}{2}^{\mathrm{m}}$, and a possible one of 7^{m} or 8^{m}, or even more.

2. Webs or wires are placed so as to cut off similar segments of the disc on each side of the central meridian.

3. Webs or wires are placed as tangents to the ends of a spot and the times noted (*a*) when the first web bisects the disc; (*b*) when the webs cut off equal sections of the disc; (*c*) when the second web bisects the disc. The mean of (*a*) and (*c*) should not differ more than 1^{m} from (*b*). This is Professor Pritchett's method (*Astronomische Nachrichten*, vol. xcvi., p. 223).

4. A thick wire (of known thickness) is placed so as to bisect the disc, while another wire is tangent to one limb of the planet. The times are noted (1) when the preceding end of the spot touches the thick wire; (2) when it reappears at the other edge of the wire. Then the mean of the times is the time of transit of that end of the spot. Similarly for the following end. This is Jedrzejewicz's method. (See *Astronomische Nachrichten*, vol. xcix., p. 211.)

5. When Mr. Barnard used a micrometer he "bisected the equatorial belts by a vertical micrometer wire, and noted the time when the object passed behind the wire" (*Monthly Notices*, vol. lii., p. 7).

6. *Micrometer measures from the two limbs of the planet to the spot.*—This is, of course, the best of all, when the atmospheric conditions and the driving of the clock are good. A considerable saving of time is also effected by this method; one has not to wait until the spot is central; its position may be measured nearly as soon as it is distinctly seen; though, of course, the best results are obtained when the spot is not more than 30^{m} from the central

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meridian. Measures may be made on one or both sides of the meridian, and they may be repeated three or more times, so as to reduce the accidental errors. This method has been most extensively used by Professor Hough, of the Dearborn Observatory, Chicago. For his fine series of measures, the formulæ necessary for the reduction of the measures to the central meridian, and his careful discussion of them, see the Annual Reports of the Dearborn Observatory, and especially that for 1882. From measures on thirty-one nights he found the mean error of a single pair of measures $\pm 0^{m}\cdot 9$, and $\pm 0^{m}\cdot 4$ for the average mean probable error for any day.

In conclusion, we may gather from the above notes that careful eye-estimates (the line joining the eyes being placed parallel to the belts), on good nights, and after some practice, will be worthy of confidence, and form useful contributions to the study of the phenomena of the planet.

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Note on the Period of T Centauri. By Alex. W. Roberts.

The minimum of *T Centauri* which took place in April 1896 happened at the same time as full moon, and so a direct determination of it was impossible.

Observations taken immediately before and after the minimum indicates that the minimum took place 1896 April 26. A minimum (observed both by Lieut.-Col. Markwick and myself) took place on 1895 April 26, and between these two dates there are four light variations, three of which have been observed at Lovedale. We thus obtain for *T Centauri* a period of 91·5 days, a period in satisfactory agreement with that already determined (*Monthly Notices*, March 1896, vol. lvi., p. 349), viz., 91·2 days.

In his *Ephemeriden veränderlicher Sterne für* 1896, page 2, Dr. Hartwig considers that a period of 360 days satisfies the earlier measures. Considering four periods to have taken place in 360 days we obtain a period of 90 days. Still some uncertainty must surround a determination of this kind, inasmuch as it is obtained simply from observations taken at or near maximum, and the maximum of *T Centauri* is not so distinctly marked as the minimum phase.

I hope by the close of the year to deal more fully with this, as well as with other southern long period variables; my present purpose, however, is fulfilled in substantiating the period given in the paper already referred to.

Lovedale:
May 1896.